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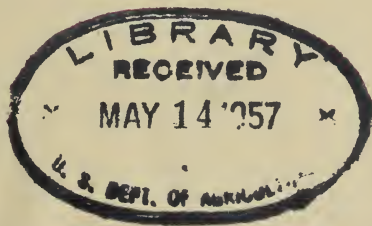
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# 3 THE IMMUNIZATION OF YOUNG PIGS AGAINST HOG CHOLERA //

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## The Immunization of Young Pigs Against Hog Cholera

A determination of the ages at which hogs may be successfully immunized against cholera is of the greatest importance to the farmer. However, although this question has been discussed for years, there are records of but few carefully controlled experimental studies of the subject.

Quite a few years ago Dr. Cahill was the first to publish records of an experimental study of this question. He administered the simultaneous inoculation to several thousand sucking pigs and reported that later about 75 per cent of them were found to be susceptible to cholera. On the other hand, Niles and Rietz, using a much smaller number of pigs it is true, reported that after the immunization of 177 sucking pigs, exposed to cholera from 5 to 9 months later, all were found to be completely immune against the disease. Others have touched upon this subject at various times but we mention these two instances of experimental work merely to show what a wide divergence of opinion has been expressed by qualified men.

A little consideration is sufficient to show that the immunization of pigs before weaning has much to recommend it, provided, of course, the immaturity of the sucking pigs is not a bar to the acquirement of a permanent and lasting immunity.

The first and foremost advantage of treating young sucking pigs appears to be the cheapness of the process. There can be little doubt that the amount of serum required for suckling would not be more than half of that which is now used for weaned shotes. There are other advantages, such as the protection of the pigs during the sucking period as well as after weaning; the greater ease of handling the small animals, and also the possibility that the sucklings might not suffer the loss in condition which no doubt takes place almost always after the simultaneous inoculation of shotes and older hogs which are almost universally placed on reduced rations for two or three weeks after treatment. If this loss of condition did not occur in the suckling pigs we might expect that they could be ready for market two or three weeks earlier or that they would be of a greater weight at marketing time. For spring pigs, early marketing is generally very desirable as the market frequently is going down with the heavy runs and anything that will tend to help getting them to market earlier is of value.

These important considerations, taken together with the very conflicting statements found in the literature, convinced us that the question of the advisability of vaccination of sucklings should be settled



one way or another. As a result of Dr. Mohler's active interest in this question, and of a very hearty cooperation between the Animal Husbandry and the Biochemic Divisions of the Bureau of Animal Industry, we have been afforded the opportunity of studying the effect of sucking pig immunization under practical farm conditions, and yet with the most rigid scientific control, for a period covering about five years. We feel that we are especially indebted to Mr. E. Z. Russell, who is in charge of the Swine Husbandry Investigations, of the Division of Animal Husbandry. His advice and criticisms have been of the greatest value, and his willingness to permit the use of his experimental pigs for this immunization work has made it possible to procure the data which we have to present to you today.

The Animal Husbandry Division controls six different farms upon which our experimental work has been done. One of these has been located at Beltsville, Md., near Washington; another at McNeill, Miss.; a third at Jeanerette, La.; a fourth at Newell, S. D.; a fifth at Ardmore, S. D., and a sixth at Huntley, Mont. As stated already, our experience covers a period of five years. For the most part the pigs were from immune sows and included representatives of six different breeds—Berkshires, Durocs, Chester Whites, Poland Chinas, Hampshires and Tamworths, together with some nondescript pigs known as Piney Wood Rooters. The work was begun at the Beltsville, Md., farm in 1921. On the other farms it began in 1923. The age of the pigs at the time of treatment has varied from one day to a little more than nine weeks. Thirty per cent of all the pigs immunized were less than three weeks of age at the time of immunization. The method of immunization has been to inject the serum into the axillary space and the virus into the flank. The dose of serum and virus during the course of the experiments has been varied to some extent, a question which we will discuss later. After immunization no change whatever was made in the feed of the pigs or of the sows. The time elapsing between immunization and exposure to cholera has varied from three to seven and three-fourths months, and the method of exposure in order to determine whether or not the pigs were immune after such a lapse of time has been to inject each of them subcutaneously with 3 cc. of hog cholera virus which was proven to be of good virulence by the injection of non-immune pigs with the same dose. The controls in all cases contracted hog cholera as a result of such injection.

There were three questions which we were particularly interested in deciding, namely:

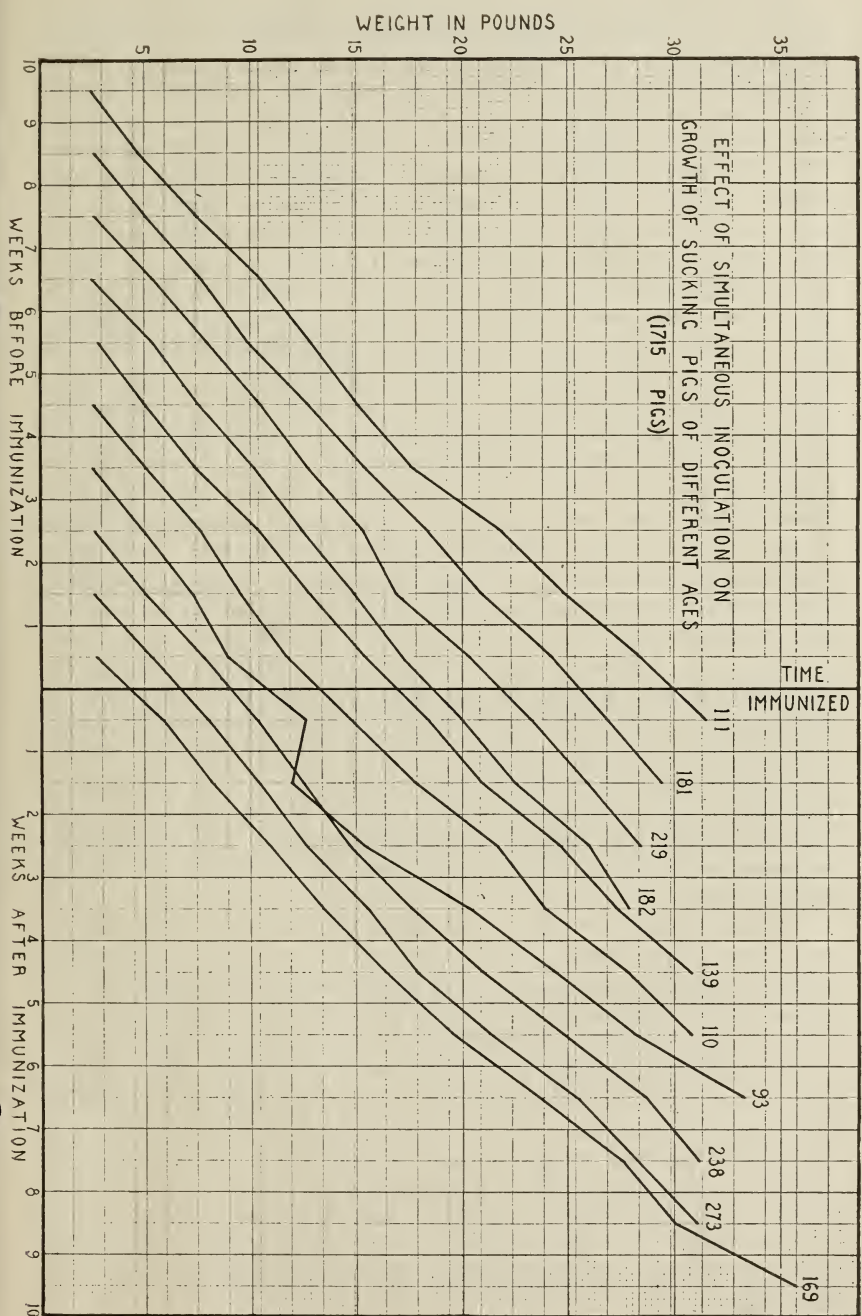
1. Does the simultaneous inoculation of the sucking pigs result in vaccination breaks; that is, sickness following the treatment and as the direct result of the treatment?

2. Is the growth of the pigs interfered with by the treatment; and

3. Are the pigs rendered immune by the treatment? By this we mean, of course, are they given a lasting immunity?

The first question is easily answered. We have given the simultaneous inoculation to 3,187 sucking pigs. Of these, not a single pig has been lost after inoculation from cholera.





At the Beltsville farm it is the regular practice to weigh all pigs at birth and weekly thereafter until they are weaned. This afforded an opportunity to secure data to answer our second question. The accompanying graph was prepared by arranging the Beltsville pigs, 1,715 in all, in age groups; that is, the first group includes pigs less than one week old when immunized. The second, less than two weeks old; the third, less than three weeks old; the fourth, less than four, and so on. The final group represents pigs nine to ten weeks old. As you may see, there were 169 pigs less than one week old, 273 less than two weeks old, 238 less than three weeks old, 93 less than four weeks old, 110 less than five weeks, and so on. The heavy vertical line in the center of the graph indicates the time of simultaneous inoculation. The rate of growth can be traced prior to inoculation and after inoculation. As you will see, these growth lines are remarkably similar. The group of pigs immunized when nine to ten weeks old is essentially a control group, and indeed the group next to it between eight and nine weeks old may be regarded in the same light. It may be seen that the groups of pigs immunized when less than one or two weeks old have essentially the same growth curves as the groups immunized at eight or nine weeks of age; it should be observed that the group lines when crossing the immunization line show practically no deviation whatever from normal except in the case of the group of pigs immunized between three and four weeks of age. The variation in this group of pigs was caused by the development of a rather severe outbreak of hog flu in the Beltsville herd during one year when the pigs were vaccinated in large part at about three weeks of age. It will be seen, however, that even this group of pigs, although apparently set back at the time indicated, eventually at the end of the tenth week reached a weight equal to or above the average of the other groups. This graph, covering as it does 1,715 pigs, is sufficient to show quite clearly that simultaneous immunization of these pigs in no way interfered with their growth and development.

It seems, then, in view of the entire lack of losses from cholera as a result of inoculation, and in view of the fact that inoculation in nowise interfered with growth, that these experiments suggest no objection to the simultaneous inoculation of sucking pigs on the ground of injury by the vaccination process.

We may then proceed to a discussion of the more important question as to the immunity derived by the sucking pigs as a result of simultaneous inoculation. In view of the number of farms involved and of the fact that the practice at the different farms varied slightly, it would take far too much time to attempt to discuss the results at each of these farms individually. Instead we shall first show a summary of all of the results at all of the farms, for all of the years of experiment and then discuss in more detail the work at the Beltsville farm near Washington.

**Table I.**  
**Summary of Results at All Stations.**

Year	Number immunized	Age in days at immunization	Number exposed	Interval immunization to exposure	Losses	Per cent
1921-1925 Beltsville	1761	1 to 70 days (3 to 8 weeks)	822 (9 sows)	4 to 7¾ mos. 12 to 16 mos.	119* 0	14.4% 0
1923-1925 Field Stas.	1426	2 to 62 days	823	2¼ to 4½ mos.	92	11.2%
<b>Total</b>	<b>3187</b>		<b>1645</b>		<b>211</b>	<b>12.8%</b>
1924 pigs eliminated	2181		980		16	1.6%
1924 pigs exclusively	1006		666		195	29.3%

As may be seen from Table I, a total of 3,187 pigs have been immunized as sucklings. Of these it was possible to expose later by virus injection 1,645. The interval between immunization and exposure varied from three to seven and three-fourths months. For the most part the length of time was five or six months. Of the 1,645 pigs exposed by injection with hog cholera virus, we have lost from cholera 211, or 12.5 per cent. Of these total losses, 195 occurred among the pigs immunized in 1924. And only 16 among those immunized in other years. The percentage loss from virus injection in 1924 was 29.3 per cent. Whereas, in all of the other years combined it was only 1.6 per cent.

In order that we may better discuss the very striking difference in the degree of immunity among the pigs immunized in 1924, and those immunized in the other four years, your attention is asked to the second table. This presents a summary of five years' work at the Beltsville, Md., farm.

Table II.  
Results at Beltsville Farm.

Year	Number immunized	Age in days at immunization	Number exposed	Interval immunization to exposure	Losses	Per cent
1921	66	3 to 64 days	7	4 months	2*	*
1922	369	4 to 70 days	65	4 to 7½ mos.	0	0
1923	519	1 to 62 days (3 to 8 weeks)	415 (9 sows)	4 to 6 mos. (12 to 16 mos.)	0	0
1924	527		237	4 to 6½ mos.	117	49.4%
1925	280	3 to 41 days	98	5 to 7¾ mos.	0	0
Total 1761			822		119*	14.4%
1924 pigs eliminated	1234		586		2*	.34%

Controls used to check exposure virus.

As may be seen, the work at this farm began in 1921 with the simultaneous inoculation of 66 pigs and has continued yearly on an extensive scale since that time. The age of the pigs, when given the protective inoculation, varied from one to 70 days. Unfortunately, in 1921 the Animal Husbandry Division could spare us but seven pigs to be used for testing immunity after inoculation, and these seven pigs were culls and runts which at the time of the immunity test were in extremely poor condition. In fact, although eight were originally sent to us by wagon from the Beltsville farm for test, one of the number died in the wagon on the way to be tested. Of the seven remaining pigs, two were almost in extremis when they reached our testing pens. Notwithstanding their condition, they were injected with virus, as were the remaining five. The virus was not sufficient to save the two pigs just referred to. They died, and so we have charged them as deaths after testing, although there is no question in our minds but that these pigs did not die as a result of the inoculation of hog cholera virus. Of the pigs immunized in the year 1922, 65 were made available to us for the purpose of testing their immunity, and as you will see, all remained well after being injected with hog cholera virus from four to seven months after having been given the simultaneous inoculation. In 1923, 415 pigs were made available for immunity tests four to six months after inoculation. Of these, none died following the virus injection. Up to this point, then, we had practically a perfect score. In 1924 we exposed, from four to six and one-half months after immunization, 237 pigs, of which 117, or 49.4 per cent, contracted cholera as a result of the virus injection. In 1925, the spring of this year, there were immunized 280 pigs, of which 98 already have been injected with 3 cc. of virus subcutaneously, 5 to



7 months after the date of immunization. All of these pigs have remained well.

It should be remembered that at every period when the immunity of these inoculated pigs was tested by virus injection, the same virus was injected into non-immune pigs as a control on the virulence of the virus. Never less than three, and at times as many as 10 such controls, were used. In every single case the controls have contracted cholera.

It is evident, then, that the immunization of sucking pigs has yielded all that could be desired in the way of a lasting immunity in every one of the five years except 1924. It is great importance to consider closely the results in 1924 as compared with other years. Were the unsatisfactory 1924 results due to the age of the pigs treated or to some other factor?

**TABLE III.**  
**Comparison of 1924 and 1925 Results, Beltsville Farm.**  
**1924**

Number exposed	Age in days at immunization	Dosage immunization	Interval immunization to exposure	Losses	Per cent
94	6 to 27 days	1 V - 10 S	4 to 6½ mos.	17	18.1%
67	30 to 53 days	Varied doses	4¾ mos.	54	80.6%
76	54 to 75 days	Varied doses	4¾ mos.	46	60.5%
237				117	49.4%

**Beltsville Farm**  
**1925**

Number exposed	Age in days at immunization	Dosage immunization	Interval immunization to exposure	Losses	Per cent
20	4 to 21 days	Varied doses	5 to 6 mos.	0	0
48	3 to 16 days	Varied doses	6 to 7¾ mos.	0	0
30	17 to 31 days	Varied doses	6 to 7¾ mos.	0	0
98				0	0

Table No. III gives, in some detail, the inoculation and exposure history of the pigs tested for immunity in 1924 and 1925 at Beltsville. As may be seen from the table, in 1924 94 pigs from 6 to 27 days of age were given the simultaneous inoculation. These pigs were exposed by injecting hog cholera virus 4 to 6½ months after the pigs had been immunized. Of the total number, 17 were lost, or 18.1 per cent. Of

67 pigs 30 to 53 days old, exposed after 4 $\frac{3}{4}$  months, 80.6 per cent were lost and of 76 from 7 to 10 weeks of age at the time of immunization, 60.5 per cent were lost as a result of virus injection 4 $\frac{3}{4}$  months later. In 1925, of 98 pigs immunized and tested, none were lost. As the table shows, these pigs were from 3 to 31 days old when immunized. They were on the average much younger at the time of immunization than the pigs of the 1924 lot, and none of them were as much as 5 weeks of age. There is certainly nothing in these figures to indicate that age was a controlling factor in so far as susceptibility to disease is concerned. If we turn to other years in considering the effect of age, the story is the same, for in 1921, 1922 and 1923 very young pigs as well as considerably older pigs were given the simultaneous inoculation and when later tested by virus injection were all found to be immune, as explained previously.

It should be mentioned at this time that beginning in 1924 we began to change the dosage of serum and virus. Prior to that time we did not use doses of serum less than 20 cc. and in the case of very large pigs at times as much as 30 cc. was employed. At the same time the amount of virus per pig varied from  $\frac{3}{4}$  of a cubic centimeter to 2 cubic centimeters. In 1924 we considered it advisable to study the effect of smaller doses of serum. The dose of serum in that year was therefore varied from 10 to 20 cc. Where possible single litters were treated with varying doses, some pigs being given 1 cc. of virus and 10 cc. of serum, others 1 cc. and 20 of serum, and others 4 cc. of virus with 10 cc. of serum, and similar variations. The idea naturally suggested itself that perhaps this change in dosage might in some way have been responsible for the failure of the 1924 pigs to receive lasting immunity. However, it was not possible after a very careful study of the dosage and of the results of immunity tests, in any way to correlate the losses with the dose of either serum or virus. Furthermore, in order to obtain more light on the effect of the dose of serum and virus, we proceeded in 1925 to apply the same system of dosage as was used in 1924, that is, from 1 to 4 cc. of virus was administered with 10 cc. of serum and from 1 to 4 cc. of virus with 20 cc. of serum. In some cases doses of 15 cc. of serum were used. Ninety-eight pigs, some immunized with each of these combinations, have been tested. As was shown by the table, all of these pigs proved to be immune when tested by virus injection. There is, therefore, nothing to indicate that the dosage of serum and virus was responsible for the results in 1924. If the cause of those bad results was not due to the age, was not due to the dosage of serum or virus, which likewise seems out of the question, could the results have been due to the methods of feeding, or to the pigs themselves? As has been stated, these experiments were all carried out on the same farm for 5 years. The method of feeding of the sows and pigs has not been varied to any material extent throughout the experimental period. There is nothing in the feeding history of the sows or the pigs to point to any possible explanation of the 1924 results. Furthermore, the Beltsville Farm pigs themselves were as nearly alike from year to year as it



would be possible to secure. They were all from immune sows and of essentially the same breeds each year. Since the pigs from the immune sows in 1921, 1922, 1923 and 1925 all acquired a firm immunity after simultaneous inoculation, it cannot with reason be suggested that those in 1924 failed to acquire immunity because of the fact that their dams were actively immune. By thus eliminating all of the factors relating to age, dosage, feeding and the pigs themselves, we have left to consider the virus and serum used for immunization. The serum employed in all years was produced at the Bureau's Experimental Farm at Ames, and the virus was obtained from the same source. All of the serum was tested prior to use and found to be fully potent. There seems no way to connect the serum with the 1924 results. The virus was tested each year at or about the time the simultaneous inoculation of the sucking pigs was carried out and in all cases this virus proved to be virulent enough to produce sickness in the inoculated controls, although it appeared that some of the virus test pigs in 1924 did not contract as acute disease as we have been accustomed to observe. Certain possible differences in the quality of the 1924 virus have suggested themselves and are now being investigated but no conclusions are as yet possible. In 1924 the virus was tested at Ames and used for immunization at Beltsville at a somewhat later date. There is, therefore, a possibility that during shipment by mail or subsequently before us this virus was altered in potency. We are without positive proof that the virus was at fault, and yet cannot avoid the impression that the 1924 virus was lacking in some quality not fully understood, but essential to the production of a lasting immunity. Perhaps, when we have learned the true cause and have devised means for preventing breaks in immunity of pigs inoculated during the sucking period, we will have gone a long way toward eliminating any similar occurrences among pigs treated after weaning.

Looking upon these experiments as a whole, they seem to show that sucking pigs from immune sows can be given a lasting immunity; that immaturity is no insuperable bar to the acquirement of such immunity. They show, also, that young pigs at times fail to acquire immunity after simultaneous inoculation. But, as suggested above, we are inclined to attribute such failures to the virus employed for immunization rather than to the immaturity of the pigs.

These experiments confirm our faith in the efficacy of the simultaneous inoculation but to our minds they seem to point clearly to the need for more research with the object of preventing even those relatively rare occurrences, breaks in immunity of immunized pigs.

The problem thus presented is difficult and therefore attractive, as a field for investigation. A solution of it will be of inestimable value to the farming interests of the country. We shall therefore continue our experimental studies, in which we hope the various State research organizations may join.



